An ecosystem is a dynamic complex of plants, animals, microbes and physical environmental features that interact with one another**.** Humans are an integral part of ecosystems, marine and terrestrial. The “interconnectedness” within and among ecosystems is provided both by the physical environment (currents transporting organisms from one part of the ecosystem to another) and by biological interactions (kelps providing a habitat). The nature of the interconnectedness of these systems is a fundamental concept when studying ecology; each system affects the other.

A combination of human activities on land, along the coasts, and in the ocean are unintentionally but seriously affecting ecosystems by altering food webs, changing the climate, damaging habitat, eroding coastlines, introducing invasive species, and polluting coastal waters. These changes threaten ecosystems which may result in further dire consequences effecting organism inhabiting both terrestrial and marine ecosystem.

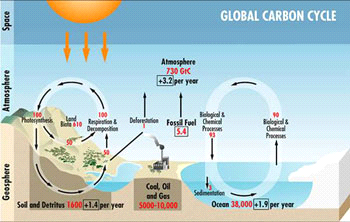
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It has been generally accepted the planet’s atmosphere is warming; both natural and anthropogenic sources of CO2  contribute to this. Scientists agree that greenhouse gases produced, especially CO2, caused by the combustion of fossil fuels and deforestation are major contributors. Average sea surface temperature has increased over the years. Water temperature changes affect the metabolism and other processes of marine plants and animals with effects throughout the food web. Marine productivity is negatively affected by increases in CO2. Any decrease in phytoplankton productivity further exacerbates biological uptake of CO2. Scientist predict as the level of greenhouse gases rise so will average global temperature. This may cause damage to sensitive ecosystems including estuaries, wetlands and coral reefs. An increased frequency and intensity of storms, hurricanes and El Nino events have also been predicted. Global warming has been linked to a rise in sea level and an increase in lowland flooding

The ocean interacts with almost every part of the earth either directly or indirectly. Through observation of the carbon cycle the flow of nutrients between the world’s forests and oceans can be seen. Most carbon dioxide is released into the atmosphere through deforestation and the burning of fossil fuels. Most CO2 is absorbed by the world’s oceans; which serve as a massive sink that traps greenhouse gas. Excess CO2 accumulates in the atmosphere trapping solar heat in the earth’s atmosphere, contributing to global warming. The impacts on marine life could be severe; the resulting change has slowed growth of plankton, corals, and other invertebrates that serve as the most basic level of the ocean food chain. Because carbon dioxide is an acid gas, the surface ocean pH is dropping. This increase in acidity makes it difficult for shell-forming animals and some algae to amass carbonate ions from the seawater to form their calcium carbonate shells. Corals, some types of mollusks, and tiny planktonic organisms called foraminifers and coccolithophorids could all be affected. Many of these species form key links in the marine food chain. The rate at which these organisms can form shells could be reduced by as much as a 25 to 45 percent. This lower productivity could lessen sedimentation in the ocean, making for future higher carbon dioxide concentration in the atmosphere and ocean. [http://news.nationalgeoHYPERLINK "http://news.nationalgeographic.com/news/2004/07/0715\_040715\_oceancarbon\_2.html"gHYPERLINK "http://news.nationalgeographic.com/news/2004/07/0715\_040715\_oceancarbon\_2.html"raphic.com/news/2004/07/0715\_040715\_oceancarbon\_2.html](http://news.nationalgeographic.com/news/2004/07/0715_040715_oceancarbon_2.html)

According to a report by the US Department of Energy on Carbon Cycling and Biosequestration one of the major challenges for 21st Century climate research is decreasing the uncertainties associated with how oceans and terrestrial ecosystems will respond to a warmer, higher-CO2 world. As the Earth continues to warm, the capacity of the ocean and terrestrial biosphere to absorb anthropogenic CO2 could peak by mid-century and then stabilize or decrease. Terrestrial carbon sinks are projected to saturate, thus a better understanding of the temperature sensitivity of long-term soil carbon pools is needed. In oceans, rising temperatures and CO2 levels are projected to decrease CO2 solubility, increase acidification in surface waters, and reduce the vertical mixing of nutrients from the deep ocean, which would limit marine photosynthesis.

<http://genomicscience.energy.gov/carboncycle/CarbonCycle012609LRnocover.pdf>



The global carbon cycle. This schematic representation shows the global carbon reservoirs in gigatonnes of carbon (1GtC = 1012 kg)

and the annual fluxes and accumulation rates in GtC/year, calculated over the period 1990 to 1999. The values shown are approximate

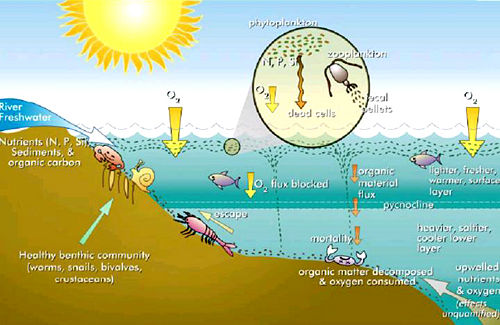
and considerable uncertainties exist as to some of the flow values. Click to veiw larger image.

(<http://www.bom.gov.au/info/climate/change/gallery/9.shtml>).

Eutrophication is an increase in the concentration of chemical nutrients, typically containing nitrogen and/or phosphorous, in an ecosystem to an extent that it increases the primary productivity of the ecosystem. Environmental effects such as anoxia, excessive plant growth and decay, reductions in water quality and fish and other animal populations may occur. Eutrophication is many times the result of nutrient pollution such as the release of sewage effluent and run – off from lawn fertilizers into natural waters. It may also occur naturally in situations where nutrients accumulate or where they flow into systems on an ephemeral basis. In aquatic environments, increased growth of choking vegetation or algal blooms disrupts normal functioning of the ecosystem. Algal blooms limit sunlight to bottom dwelling organisms and decrease the level of dissolved oxygen in the water, needed for fish and shellfish to survive. Anoxic conditions may occur, promoting growth of anaerobic bacteria that produces toxins deadly to birds and mammals. Eutrophication decreases the resource value of rivers, lakes, and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered. Where conditions interfere with drinking water treatment health related problems may occur.

Terrestrial ecosystems are also subject to similarly adverse impacts. Increased content of nitrates in soil frequently leads to undesirable changes in vegetation composition and many plant species are endangered as a result of eutrophication in terrestrial ecosystems. Ecosystems that are characterized by low nutrient content and species-rich, slow growing vegetation are overgrown by faster growing and more competitive species-poor vegetation, like tall grasses, that can take advantage of elevated nitrogen levels causing vulnerable species to be lost.

Toxic compounds produced by the algal can result in animal mortality. When the algae die or are eaten, neuro and hepatotoxins are released that can kill animals and can be accumulated in shellfish; poisoning humans that consume them. When nitrogen is leached into groundwater, drinking water can be affected because concentrations of nitrogen are not filtered out. Nitrate has been shown to be toxic to babies as bacteria in the gut convert nitrate to nitrite which reacts with hemoglobin to form methemoglobin, which does not carry oxygen.



How eutrophication works in an estuary (from US Environment Protection Agency).

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| --- |
| *Adverse effects on lakes, reservoirs, rivers, and coastal marine waters caused by eutrophication (from Carpenter* et al. *1998; modified from Smith 1998)* |
| * Increased biomass of [phytoplankton](http://www.newworldencyclopedia.org/entry/Plankton) * Toxic or inedible phytoplankton species * Increases in blooms of gelatinous zooplankton * Increased biomass of benthic and epiphytic [algae](http://www.newworldencyclopedia.org/entry/Algae) * Changes in macrophyte species composition and biomass * Decreases in water transparency * Taste, odor, and water treatment problems * Dissolved oxygen depletion * Increased incidences of [fish](http://www.newworldencyclopedia.org/entry/Fish) kills * Loss of desirable fish species * Reductions in harvestable fish and shellfish * Decreases in perceived aesthetic value of the water body |

Any factor that causes increased nutrient concentrations can potentially lead to eutrophication. Numerous ecological effects can arise where primary production is stimulated including decreased biodiversity, changes in species composition and dominance, and toxicity effects. Eutrophication is widely seen as a negative trend in lakes and the sea, since it benefits animals and plants normally considered undesirable – including smaller cyprinid fishes such as roaches, aquatic plants that can overgrow shores and bays, and toxic blue green algae. On the land, increases in the productivity of plants are more welcomed, particularly where crops and commercially managed forests are concerned. Terrestrial ecosystems are also normally spared from the more harmful side effects of eutrophication such as oxygen depletion.

Land transformation and habitat degradation play a large role in influencing ecosystems. Extinctions and the loss of habitat are a result of degradation. Approximately 25 percent of the terrestrial continental surface of the planet is currently under some type of cultivation system. In cultivated ecosystems, increased agriculture and the greater use of a few modern varieties of crops have reduced the genetic diversity of domesticated plants and animal (2005, Samper). In forest ecosystems, both temperate and tropical, land use and land use change are causing diminished biodiversity. In marine ecosystems, fisheries have declined tremendously because of growing global demand for food and animal feed. Marine species exploited for commercial purposes has been reduced by 90 percent in much of the world since commercial fishing began.

Land transformation and habitat degradation has reduced the range of many species. Many species have gone extinct locally or globally and the population size of many species is decreasing. Invasive species are increasing their geographic range affecting interactions among species and the functioning of ecosystems. Deforestation has affected flooding; in many parts of the world the number of floods is directly proportional to the loss of forests. <http://www.actionbioscience.org/environment/samper.html>

Humans affect marine ecosystems through a wide variety of activities on land, on the coasts, and in the ocean. The impacts of these activities interact, often in synergistic ways. Land-based activities have major impacts on marine ecosystems via run-off and atmospheric deposition of nutrients and chemical pollutants, alteration of coastal habitats such as wetlands and estuaries, alteration of flows of water and sediment to coastal areas, deposition of marine debris, and global climate change. Among coastal and oceanic activities (such as aquaculture, coastal development, fishing, military activities, and shipping), fishing has the most obvious impact. Ecosystem effects of fishing result from the removal of substantial amounts of life, reduction of the average size and age of individuals within a population, removal of a large percentage of top predators (thereby altering the function of marine food webs), collateral damage to non-target species (often endangered species) via by catch, and degradation or destruction of bottom habitats by fishing gear. These can in turn affect the structure and functioning of ecosystems, reduce productivity of the system, and impede the delivery of services.

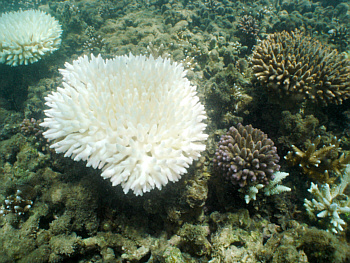
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A recognized potential consequence of a continued rise in atmospheric CO2 is global warming. Coral reefs provide a marine habitat for a plethora of marine species. Here these species find food and shelter which in turn support economically valuable recreational and commercial fishing. Coral reefs also form a breakwater for adjacent coasts, providing natural protection from erosion and storm surges. Reefs help generate revenue for the tourism industry by providing hotspots for scuba diving and snorkeling experiences. Impacts of global warming on land have resulted in glaciers melting which disrupt normal patterns of river flow and damaging species that depend on these rivers. Food sources for migratory animals may not be available due to early bloom times caused by global warming. Rising sea levels are ruining freshwater supplies in island nations like Tuvalu and the Solomon Islands making them more vulnerable to storms and flooding (January 2007, *Undercurrent*).

According to Dr. Craig D Idso in *CO2, Global Warming and Coral Reefs: Prospects for the Future* global warming caused by high CO2 levels is believed to cause an increase in the damage to corals by magnifying the intensity, frequency and duration of the number of environmental stresses to which they are exposed. <http://scienceandpublicpolicy.org/images/stories/papers/originals/coral_co2_warming.pdf> Coral reefs thrive in specific conditions; they utilize an algal symbiont, zooxanthellae, living within the coral to provide it with energy in the form of translocated reduced carbon compounds, such as glucose, glycerol, and amino acids, which are the products of photosynthesis. Zooxanthellae can provide up to 90% of a coral’s energy requirements. In return, the coral provides the zooxanthellae with protection, shelter, nutrients (mostly waste material containing nitrogen and phosphorus) and a constant supply of carbon dioxide required for photosynthesis. Available nutrients, incident light, and expulsion of excess cells limit their population.

Zooxanthellae directly or indirectly experience the stress that their containing corals undergo. Exposure to air during low tides and damage from solar radiation in shallow water environments are two of the ecological stressors coral and zooxanthellae face. Temperature changes now provide the most stress to the zooxanthellae-coral relationship; temperature changes induce cell adhesion dysfunction which detaches zooxanthellae from their cnidarian endodermal cells. This is referred to as coral bleaching; zooxanthellae densities within coral tissue become low or the concentration of photosynthetic pigments within each zooxanthella decline. The result is a ghostly white calcareous skeleton. The coral then die unless conditions improve enough to allow the zooxanthellae to return. Ocean acidification, which occurs when oceans absorb carbon dioxide from the atmosphere, is also a threat to corals. As the oceans become more acidic, the corals’ ability to form skeletons through calcification is inhibited.

healthy coral bleached coral



Coral reefs are referred to as the rainforests of the ocean, both systems are highly diverse, are suffering from human impacts, and are worthy of protection and conservation. Both reefs and tropical rainforests support a complex habitat structure, and are highly productive and diverse. With incredibly diverse populations of plants and animals, both ecosystems feature complex food webs and demonstrate remarkably efficient systems of recycling nutrients to sustain their populations. Rain forests and coral reefs often exist within the same regions, with coral reefs off-shore from many of the world's rain forests – or the land where rain forests once existed. The health of rain forests depends on water nearly to the same extent as its underwater counterpart. The world's driest rain forest receives almost seven feet of water a year; the wettest receives almost 25 feet. Unfortunately, the negative impact of human actions on the two environments is another trait shared by the two environments.